

Review and revision of the century-old types of *Cardiodactylus* crickets (Grylloidea, Eneopterinae, Lebinthini)

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ABSTRACT

In this study I review and revise the nine species of *Cardiodactylus* Saussure, 1878 crickets described before 1915, based on detailed analysis of the type specimens studied in several institutions, together with a critical review of the original descriptions. Seven species are thus confirmed or re-established as valid species (*C. novaeguineae* (Hann, 1842), *C. canotus* Saussure, 1878, *C. gaimardi* (Serville, 1838), *C. haani* Saussure, 1878, *C. guttulus* (Matsumura, 1913), *C. pictus* Saussure, 1878 and *C. rufidulus* Saussure, 1878), then assigned to a species group and redescribed by combining information from old type series and newer material; two species are considered as *nomen dubium* (new status or confirmation of previous hypotheses: *C. praecipuus* (Walker, 1869) and *C. philippinensis* Bolívar, 1913); and two species described recently are synonymised with older species (*C. boharti* Otte, 2007 under *C. guttulus*, *C. tathimani* Otte, 2007 under *C. rufidulus*).

KEY WORDS

Insecta,
Orthoptera,
Grylloidea,
Eneopterinae,
Lebinthini.

RÉSUMÉ

Réexamen et révision des types centenaires de grillons *Cardiodactylus* (Grylloidea, Eneopterinae, Lebinthini).

Dans cette étude je réexamine et révisé les neuf espèces de grillons *Cardiodactylus* Saussure, 1878 décrites avant 1915 en m'appuyant sur l'analyse détaillée des spécimens types provenant de plusieurs institutions, ainsi que sur la lecture critique des descriptions originales. Sept espèces sont ainsi confirmées ou ré-établies comme espèces valides (*C. novaeguineae* (Hann, 1842), *C. canotus* Saussure, 1878, *C. gaimardi* (Serville, 1838), *C. haani* Saussure, 1878, *C. guttulus* (Matsumura, 1913), *C. pictus* Saussure, 1878 et *C. rufidulus* Saussure, 1878), puis assignées à un groupe d'espèces et redécrites en combinant des informations provenant de l'étude des types et de matériel récent ; deux espèces sont considérées comme *nomen dubium* (nouveau statut ou confirmation d'une hypothèse précédente : *C. praecipuus* (Walker, 1869) et *C. philippinensis* Bolívar, 1913) ; et deux espèces décrites récemment sont mises en synonymie avec des espèces plus anciennes (*C. boharti* Otte, 2007 sous *C. guttulus*, *C. tathimani* Otte, 2007 sous *C. rufidulus*).

MOTS CLÉS

Insecta,
Orthoptera,
Grylloidea,
Eneopterinae,
Lebinthini.

INTRODUCTION

Cardiodactylus Saussure, 1878 is currently the most speciose and diverse genus of the cricket subfamily Eneopterinae. It is part of the tribe Lebinthini, which is widely distributed from Southeast Asia to Northern Australia and New Caledonia, and in many archipelagos in the Western Pacific (e.g., Otte & Alexander 1983; Robillard & Desutter-Grandcolas 2004a, 2006, 2008; Robillard 2009, 2010, 2011; Robillard *et al.* 2010). *Cardiodactylus* also occupies an important part in the acoustic diversity of Eneopterinae (Robillard & Desutter-Grandcolas 2011): Based on the analysis of the frequency spectra of the calling songs, previous studies showed that *Cardiodactylus* species use high-frequency calling songs (Robillard & Desutter-Grandcolas 2004b), with a dominant frequency corresponding to the third peak of their song spectrum (Robillard *et al.* 2007). In terms of species richness, *Cardiodactylus* has recently grown by a factor of about 500 % (Otte 2007a, 2007b: 39 new species; Robillard 2009: 4 new species; Ma & Zhang 2010: 1 new species; Robillard 2011: 2 new species). Continued fieldwork and museum studies show that the diversity of this genus still remains undescribed. Nevertheless, most

of the species of *Cardiodactylus* described before this recent burst of interest for this genus have never been addressed in comparison to the new data and/or using modern criteria used in cricket systematics (but see Robillard & Ichikawa 2009 for such analysis of two species). It is thus necessary to clarify the status of these names before going forward in the investigation of geographical and phenotypic diversification of *Cardiodactylus*, in order to establish a comprehensive taxonomical reference for the genus.

In this paper, I revise the species of *Cardiodactylus* described before 1915. These nine one-hundred-years-old species were only briefly mentioned and discarded by Otte (2007a) in his paper describing 39 new species of *Cardiodactylus*. I provide here detailed information from the type specimens studied in the MNHN collection or in several other institutions, together with a critical review of the original descriptions and type localities of the old *Cardiodactylus* species. I discuss the status to give to each of these species and redescribe them when possible and necessary (Table 1): seven species are thus validated, assigned to a species group and redescribed by combining information from type series and newer material, and two species

TABLE 1. — List of *Cardiodactylus* Saussure, 1878 species described before 1915 and their revised status.

Species	Status
<i>Cardiodactylus novaeguineae</i> (Haan, 1842)	valid species (redescribed in Robillard & Ichikawa 2009)
<i>Cardiodactylus canotus</i> Saussure, 1878	valid species (redescription)
<i>Cardiodactylus gaimardi</i> (Serville, 1838)	valid species (new status, redescription)
<i>Cardiodactylus guttulus</i> (Matsumura, 1913)	valid species (redescribed in Robillard & Ichikawa 2009)
<i>Cardiodactylus haani</i> Saussure, 1878	valid species (redescription)
<i>Cardiodactylus philippinensis</i> Bolívar, 1913	<i>nomen dubium</i> (new status)
<i>Cardiodactylus pictus</i> Saussure, 1878	valid species (redescription)
<i>Cardiodactylus praecipuus</i> (Walker, 1869)	<i>nomen dubium</i> (confirmation)
<i>Cardiodactylus rufidulus</i> Saussure, 1878	valid species (new status, redescription)

are considered (newly or confirmation of previous hypotheses) as *nomen dubium*. To emphasise how important it is to address in detail the species described by past authors while studying recent material, it is interesting to notice that two of the new species described by Otte (2007a) were in fact previously described and should be considered as junior synonyms (*C. boharti* Otte, 2007 under *C. guttulus* (Matsumura, 1913), *C. tathimani* Otte, 2007 under *C. rufidulus* Saussure, 1878). Interestingly, *C. brandti* Otte, 2007 is very close to *C. gaimardi* (Serville, 1838), and the specimens identified *C. haani* Saussure, 1878 by Otte (2007) is in fact a new species yet to be described.

MATERIAL AND METHODS

MATERIAL EXAMINED

Most of the material examined here belongs to the collections of the Muséum national d'Histoire naturelle, Paris. Specimens were also studied from the Natural History Museum, London; Naturhistorisches Museum, Vienna and Nationaal Natuurhistorisch Museum, Leiden and Muséum d'Histoire Naturelle de Genève (see below for the list of material examined per species and museum abbreviations).

METHODS

Male tegminal venation

Male tegminal veins and cells are named after Ragge (1955) and Desutter-Grandcolas (2003) for Ensifera, and Robillard & Desutter-Grandcolas (2004a) for the subfamily Eneopterinae more specifically.

Male and female genitalia

Whenever possible, male and female genitalia have been dissected in softened specimens by cutting the membranes between the paraprocts and the subgenital plate, or between the ovipositor and the subgenital plate respectively; they have been cleaned with cold KOH and have been observed using a binocular microscope Leica MZ16 at magnifications up to 115, and then kept in glycerine in vials pinned under specimens. Male genitalia are named according to Desutter (1987), modified in Desutter-Grandcolas (2003) and Robillard & Desutter-Grandcolas (2004a). Photographs of male genitalia were obtained using an AmScope MU1000 digital camera (www.amscope.com), except for the male genitalia of *C. pictus* Saussure, 1878, photographed with a simple digital camera. Dotted parts in figures correspond to membranous areas.

ABBREVIATIONS

Morphology and tegminal venation

1A-4A	first to fourth anal veins;
c1-3	first to third cells of C alignment;
CuA	anterior cubitus;
CuA1, CuA2, ...	first, second, ... bifurcations of CuA;
CuP	posterior cubitus;
d1 cell (mirror)	first cell(s) of D alignment;
FIH	hindfemur;
FW	forewing;
HW	hind wing;
Ias	inner spines on TIII dorsal side;
	above the spurs;
Ibs	inner spines on TIII dorsal side;
	between the spurs;
M	media vein;

Oas	outer spines on TIII dorsal side; above the spurs;
Obs	outer spines on TIII dorsal side; between the spurs;
R	radial vein;
Sc	subcostal vein;
III-1, III-3	first and third segments of hind leg (tarsomere).

Measurements

FIIL	length of hind femora;
FIILW	width of hind femora;
FWL	forewing length;
FWW	forewing width (at the level of maximal width);
HWT	hindwing tail length (part of the hind wings longer than the FWs);
OL	ovipositor length;
PronL	pronotum length;
PronW	pronotum width;
TIIL	length of hind tibiae.

Institutions

AMNH	American Museum of Natural History, New York;
BMNH	Natural History Museum, London;
BPBM	Bernice P. Bishop Museum, Department of Zoology, Honolulu;
MHNG	Muséum d'Histoire Naturelle de Genève;
MNCN	Museo Nacional de Ciencias Naturales, Madrid;
MNHN	Muséum national d'Histoire naturelle, Paris;
NHMW	Naturhistorisches Museum, Vienna;
RMNH	Nationaal Natuurhistorisch Museum, Leiden.

SYSTEMATICS

Subfamily ENEOPTERINAE Saussure, 1874
Tribe LEBINTHINI Robillard, 2004

Genus *Cardiodactylus* Saussure, 1878

TYPE SPECIES. — *Cardiodactylus novaeguineae* (Haan, 1842).

DIAGNOSIS. — Among Lebinthini genera, *Cardiodactylus* is characterised by its large size, long wings most often with whitish spots in both sexes, male FW venation (W-shaped harp veins, mirror incomplete generally elongated longitudinally), and male genitalia (pseudepiphallic dorso-lateral ridges, posterior apex of pseudepiphallic more or less spoon-like).

Cardiodactylus novaeguineae (Haan, 1842)

Gryllus (Platydictylus) novae-guineae Haan, 1842: 233.

Cardiodactylus novae-guineae – Saussure 1878: 659 (type comparison). — Kirby 1906: 88 (type species of *Cardiodactylus*). — Chopard 1915: 149; 1929: 49; 1931b: 140; 1969: 312.

Cardiodactylus novaeguineae – Otte 1994: 65. — Robillard 2004: 29; 2006: 675 (morphological phylogeny). — Robillard & Desutter-Grandcolas 2004a: 273; 2004b: 479 (calling song); 2006: 644 (molecular and morphological phylogeny). — Eades *et al.* 2008 (Orthoptera Species File Online). — this study > valid species, effordi species group.

Cardiodactylus novaeguineae – Chopard 1968: 351. — Bhowmik 1979 (1981): 43. — Otte & Alexander 1983: 310. — Otte *et al.* 1987: 42. — Oshiro 1995: 44. — Yin & Liu 1995: 97. — Rentz 1996: 140. — Willemse 2001: 110. — Otte 2007a: 345; 2007b: 239. — Robillard *et al.* 2007. — Robillard 2009: 587. — Robillard & Ishikawa 2009: 879 (redescription and neotype designation). — Desutter-Grandcolas *et al.* 2010: 616. — Robillard & Desutter-Grandcolas 2011: 637. — Nattier *et al.* 2011: 2200 (molecular phylogeny). — Eades *et al.* 2013 (Orthoptera Species File Online).

TYPE MATERIAL. — **Neotype male**: Indonesia. Papua Province, Biak Is., XI.1953, L.v.s. Hammen (RMNH). **Paraneotypes** (7 ♂♂, 14 ♀♀): Indonesia. Papua Province, Biak [Is.], 20.II.1952, 1 ♂, L. D. Brongersma, RMNH; [Biak Is.], Base Biak, 17/24.III.1952, 2 ♂♂, 1 ♀, L. D. Brongersma & W. J. Roosdorp (RMNH); [Biak Is.], Schouten Islands, Base Biak, W of Sorido, 24.I.1955, 1 ♀, L. D. Brongersma (RMNH); Biak [Is.], X.XI.1953, 1 ♀, Pers Kon Marine (RMNH). Papua New Guinea. Manus Province, Manus Is., Lorengau, 6.VI.1967, 1 ♀, R. E. & R. M. Blackith (MNH-ENSIF2044). Morobe Province, [Papua Is.], Lae, 29.V.1967, 2 ♂♂, R. E. & R. M. Blackith (MNH-ENSIF2045, 2046). Oro Province, [Papua Is.], Mt. Lamington, 1300-1500 ft., 2 ♂♂, 4 ♀♀, C. T. McNamara, identified *Cardiodactylus novae guineae* by L. Chopard (SAMA). Milne Bay Province, Misima Is., Louisiade Arch., Narian, 0-500 m (No 8), 1956, 1 ♀, fifth Archbold Exped. to New Guinea, L. J. Brass (AMNH); Misima Is., Louisiade Arch., 1 ♀, Rev. R. J. Andrew, identified *Cardiodactylus novae guineae* by L. Chopard (SAMA); Rossel Is., Louisiade Arch., Abaleti, 0-500 m, 1 ♀, fifth Archbold Exped. to New Guinea, L. J. Brass (AMNH). New Ireland Province, New Ireland [Is.], 2 ♀♀, E. R. Waite, identified *Cardiodactylus novae guineae* by L. Chopard (SAMA).

TYPE LOCALITY. — Indonesia, Biak Island.

REDESCRIPTION AND DISTRIBUTION. — See Robillard & Ichikawa (2009).

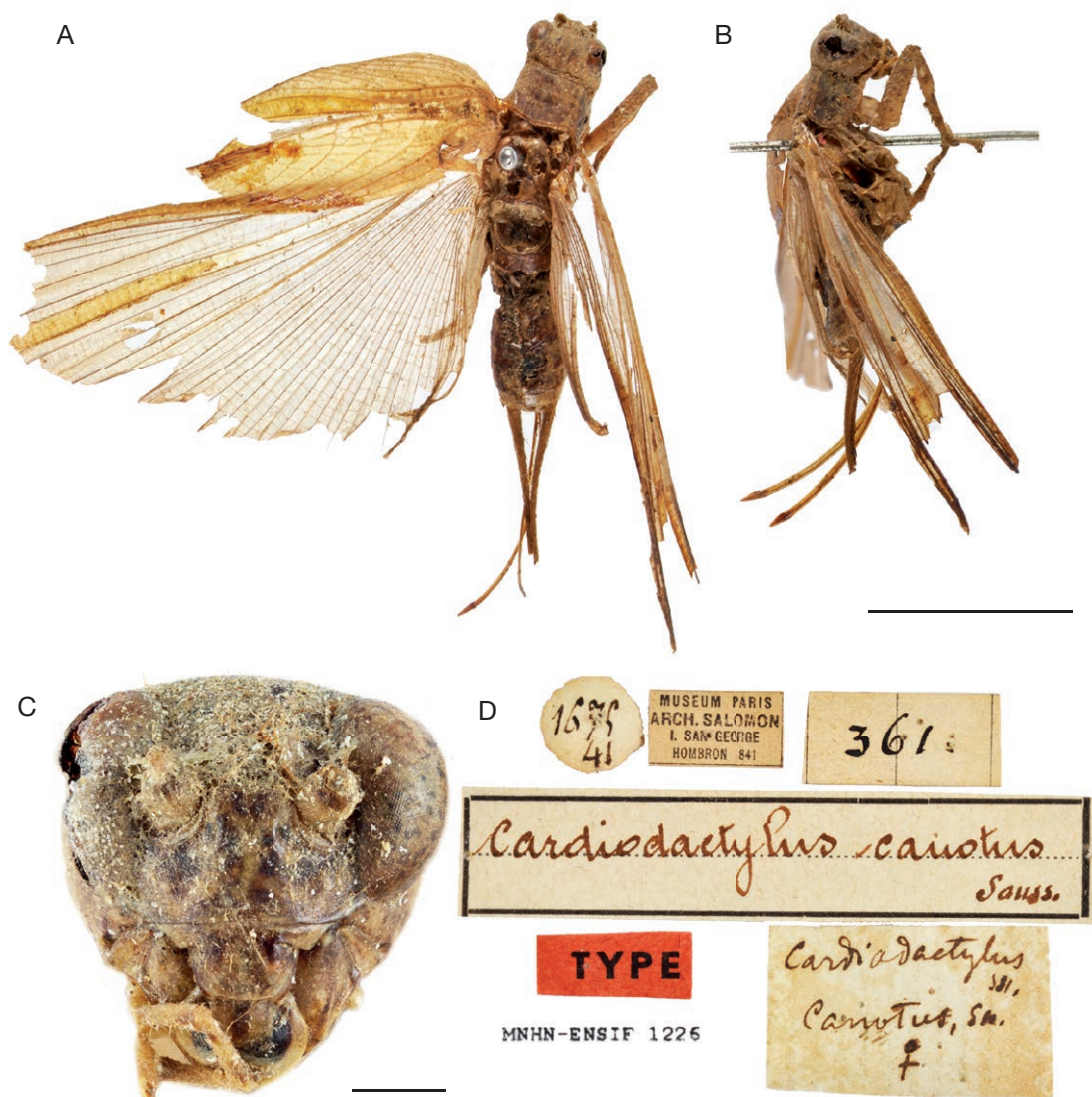


FIG. 1. — *Cardiodactylus canotus* Saussure, 1878, female lectotype: **A**, dorsal view; **B**, lateral view; **C**, head in facial view; **D**, labels. Scale bars: A, B, 1 cm; C, 1 mm.

***Cardiodactylus canotus* Saussure, 1878**
(Figs 1, 2A, 3B)

Cardiodactylus canotus Saussure, 1878: 522. — Chopard 1951: 481; 1968: 352. — Otte 1994: 65; 2007: 343 (probably synonym of *C. novaeguineae*). — Robillard & Desutter-Grandcolas 2004a: 273; 2004b: 479 (morphological phylogeny); 2006: 644 (molecular and morphological phylogeny). — Robillard 2004: 29;

2006: 675. — Eades *et al.* 2013 (Orthoptera Species File Online). — this study > valid species, effordi species group.

TYPE MATERIAL. — Female lectotype (new designation): [Solomon Islands]: Arch. Salomon, I. San George [San Jorge Island], #1675-41, 361, 1841, Hombron (MNHN-ENSIF1226).

TYPE LOCALITY. — Locality mentioned by Saussure (1878) is “La Nouvelle Hollande (S.-O). Terre du roi

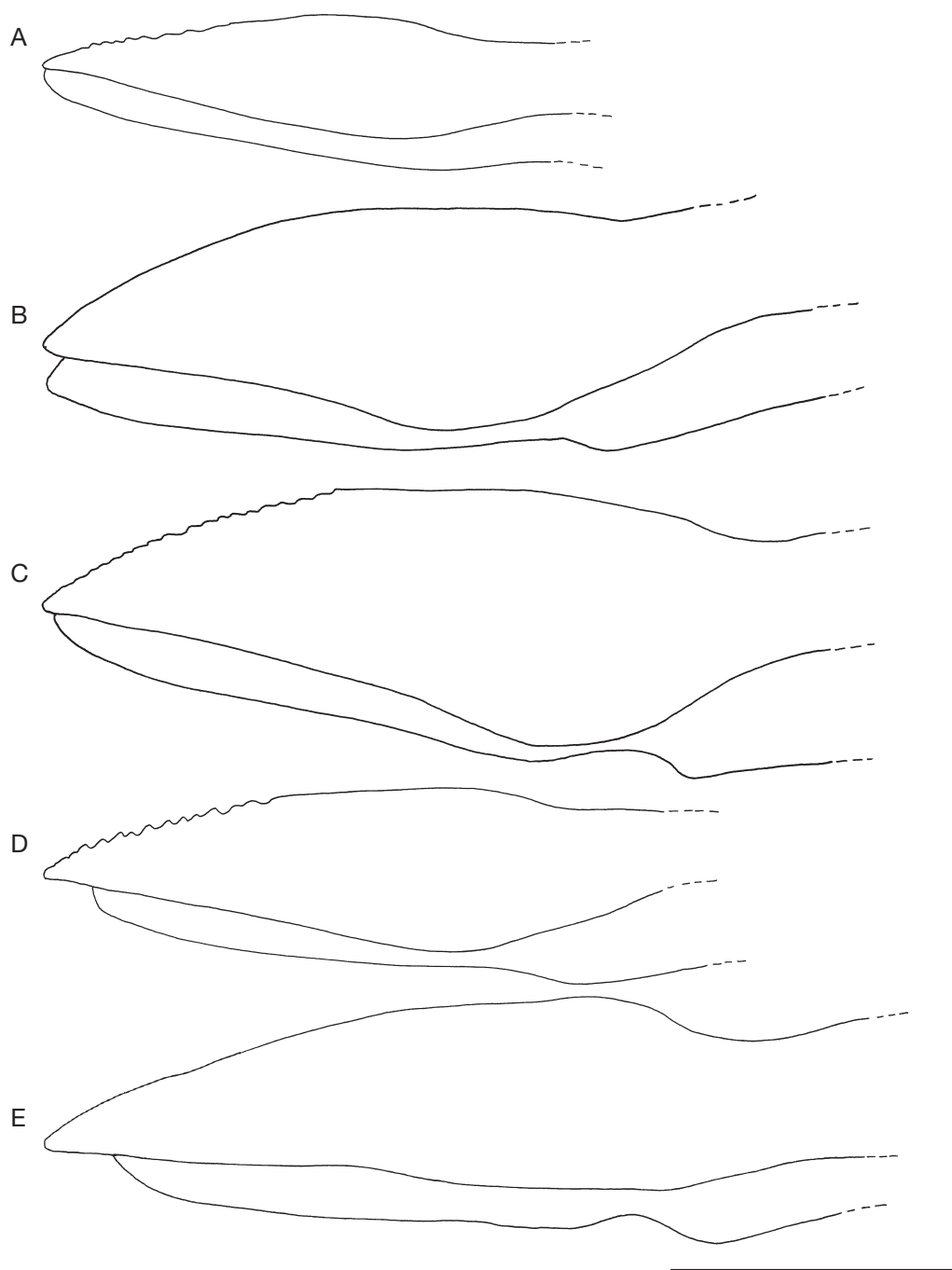


FIG. 2. — Apex of ovipositor of: **A**, *C. canotus* Saussure, 1878; **B**, *C. gaimardi* (Serville, 1838); **C**, *C. haani* Saussure, 1878; **D**, *C. pictus* Saussure, 1878; **E**, *C. rufidulus* Saussure, 1878. Scale bar: 1 mm.

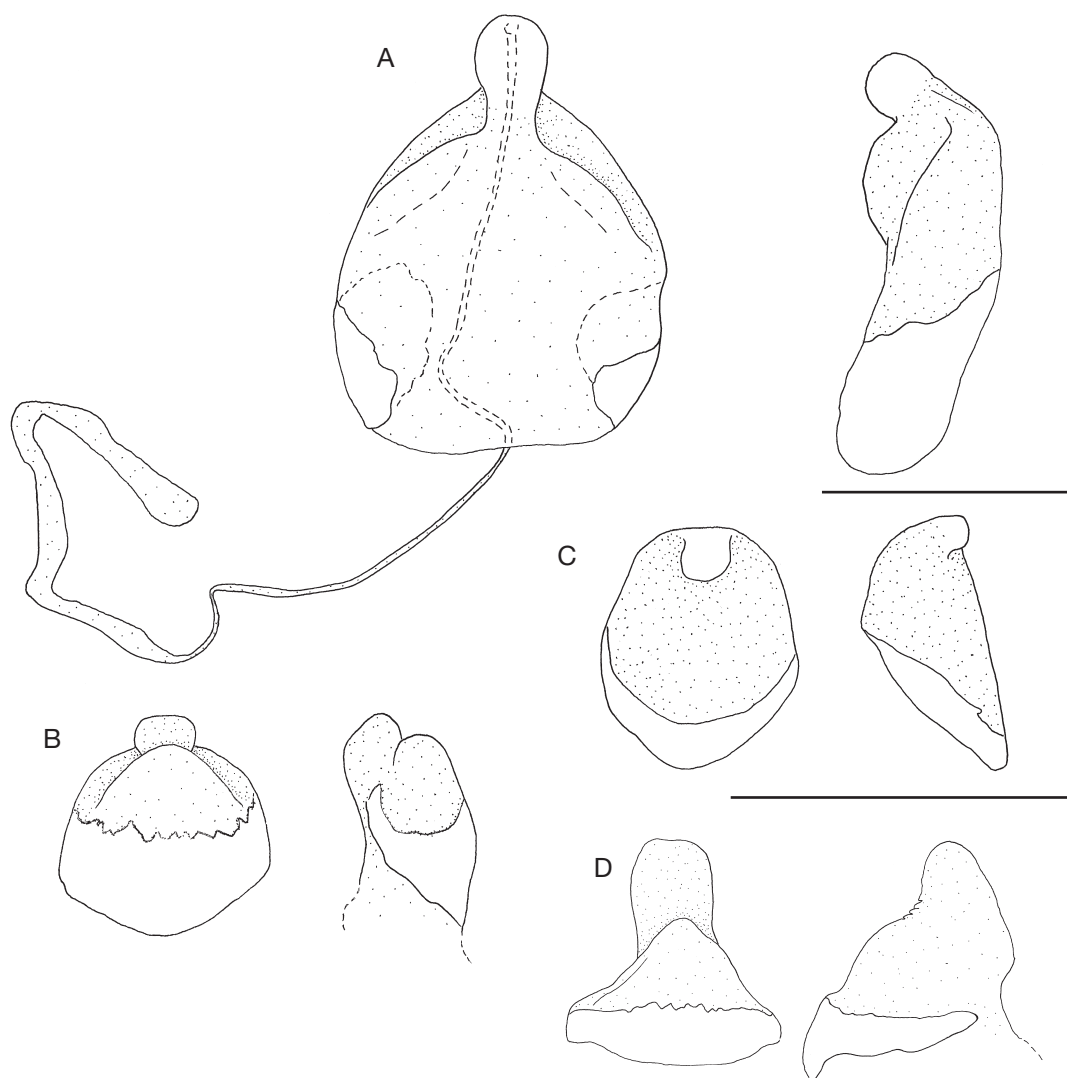


FIG. 3. — Copulatory papilla in ventral (left) and lateral (right) views of: **A**, *C. haani* Saussure, 1878; **B**, *C. canotus* Saussure, 1878; **C**, *C. pictus* Saussure, 1878; **D**, *C. rufidulus* Saussure, 1878. Scale bars: 1 mm.

Georges". The labels mention "Arch. Salomon, I. San George", which probably refers to San Jorge Island in the Solomon Islands archipelago, south of Isabel Island.

REMARKS. — The species is valid and has probably not been redescribed under another name, given its distribution and morphology. It clearly belongs to the *effordi* species group according general shape, colouration, shape of pronotum and long HWs.

REDESCRIPTION OF FEMALE LECTOTYPE

Size small for the genus, colouration mostly light brown. Eyes large and prominent, vertex yellow brown with 6 faint longitudinal bands. Fastigium trapezoidal, dark brown. Face yellow brown, mottled with brown, with 2 dark brown spots between antennae. Mouthparts yellow brown with a median dark brown area on clypeus. Scares yellow brown,

apex with a dark brown ring. Lateral part of head yellow brown. Pronotum posterior margin bisinuated; dorsal disk of pronotum yellow brown mottled with brown; lateral lobes dark brown posteriorly, ventral margin yellow brown. FWs brown, with 10 strong longitudinal veins brown, transverse veins mostly brown, some yellow near mid-length along external margin. R and Sc veins brown, R/Sc area brown mottled with dark brown. Lateral field brown, with 6 projections of Sc and 5 more ventral veins. HWs transparent brown, forming a long tail posteriorly. Ovipositor apex denticulate on dorsal edge.

Female genitalia

Copulatory papilla rounded, with a ring-shaped basal sclerite; apex rounded, curved ventrally.

Measurements

See Table 2.

Cardiodactylus gaimardi (Serville, 1838) (Figs 2B, 4)

Platydictylus gaimardi Serville, 1838: 366.

Cardiodactylus gaimardi – Haan 1842: 234. — Saussure 1878: 524. — Kirby 1906: 88. — Chopard 1931a: 15; 1940: 200; 1951: 481; 1968: 351. — Otte & Alexander 1983: 309 (*nomen dubium* type largely destroyed). — Otte 2007a: 343 (*nomen dubium*). — Robillard & Desutter-Grandcolas 2004a: 291. — Eades *et al.* 2013 (Orthoptera Species File Online, *nomen dubium*). — this study > valid species, novaeguineae species group.

Cardiodactylus novaeguineae – Otte 1994: 66 (synonymy).

TYPE MATERIAL. — **Female lectotype** (new designation): [Papua New Guinea] Australie, Luoy et Gaimard, l'astrolabe, #253 (MNHN-ENSIF1221).

TYPE LOCALITY. — In the description by Serville (1838), the type locality is “Havre Carteret, La Nouvelle Hollande”. It corresponds to a place in the south-east of New Ireland Island in Papua New Guinea.

REMARKS. — Despite the lectotype female specimen is old and “largely destroyed” (Otte 2007a), many characters of colouration, general shape, size, and FW venation can still be observed. There is consequently no reason to treat the species it as a *nomen dubium*. Combined with the clear

localisation of type locality, in the south-east of New Ireland Island, it appears that this species is very close to *C. brandti* Otte, 2007a, also from New Ireland. Most of the characters of recognitions given by Otte conform with the female lectotype of *C. gaimardi* (top of head dark brown with small pale band behind each eye, top of pronotum uniform, with distinct lateral pale bands, lateral lobes entirely dark, legs uniformly brown). The male holotype of *C. brandti* is well larger than the female lectotype of *C. gaimardi*, but Otte mentions paratypes of *C. brandti* being of similar dimension as *C. gaimardi*. According to the list of material in Otte (2007), *C. brandti* seems to occur in different places in the islands of New Ireland and New Britain, but additional material from these islands (MNHN) show that there are clearly several species close to *C. gaimardi* and *C. brandti* in terms of male genitalia and patterns of colouration. Clear reanalysis of the whole series will be necessary to decide if *C. brandti* should be considered as a junior synonym of *C. gaimardi* and describe potential new species in reference to the existing one(s).

REDESCRIPTION OF FEMALE LECTOTYPE

Size average for the genus, colouration mostly dark brown. Fastigium long, dark brown, lateral edges yellowish. Vertex almost entirely dark brown. Face and mouthparts dark yellow brown almost homogeneous, with two dark spots between antennae. Scapes dark brown. Lateral part of head dark yellow brown. Pronotum posterior margin slightly bisinuated; dorsal disk dark brown, anterior corners yellowish; lateral lobes dark brown, ventral margin partly yellow brown. Legs: Fore leg (1 remaining) dark yellow brown, with faint dark spots on femur and faint dark rings on tibia. Leg III (1 remaining) dark orange brown, knee slightly darker. Subgenital plate yellow brown. HW tail short, dark brown with yellow transverse veins. FW dorsal field brown, with 11 longitudinal veins, with a yellowish area on lateral edge near mid-length, including part of CuA and M veins. Lateral field brown, R/Sc area orange brown; Sc and its projections yellow (n = 5). Ovipositor shorter than FIHI, not denticulate, perhaps due to the age of the specimen.

Female genitalia

Copulatory papilla was not dissected because of the state of the lectotype.

Measurements

See Table 2.

TABLE 2. — Measurements of *Cardiodactylus* Saussure, 1878 species addressed in this study. Abbreviations: see Material and methods.

	PronL	PronW	FWL	FWW	HWT	FIIL	FIIW	TIIL	TIII spines				
									las	lbs	Oas	Obs	OL
<i>C. canotus</i> Saussure, 1878 Female Lectotype	2.5	3.9	>17 (broken)	3.9	?	?	?	?	?	?	?	?	12.6
<i>C. gaimardi</i> (Serville, 1838) Female Lectotype	4.1	5.6	18.9	5.7	7.6	23.3	5.9	22.1	11	7	15	10	16.6
<i>C. haani</i> Saussure, 1878 Female Lectotype	4.5	6.9	23.8	6.7	7.3	25.1	6.8	20.6	9	6	17	9	23.1
Females (n = 3) (mean)	4.3-4.5 (4.4)	6.3-6.9 (6.7)	22.2-24.3 (23.4)	6.3-6.9 (6.6)	5.9-7.3 (6.6)	24.1-25.5 (24.9)	6.3-6.8 (6.5)	20.6-21.8 (21.3)	9-12 (10)	6-7 (6)	15-17 (16)	7-9 (8)	20.6-21.8 (21.3)
<i>C. pictus</i> Saussure, 1878 Male Lectotype	2.2	3.6	12.9	2.5	?	?	?	?	?	?	?	?	—
Males (n = 3) (mean)	2.7-2.8 (2.7)	4.2-4.4 (4.3)	14.8-15.9 (15.2)	3.2-3.6 (3.4)	7.6-9.6 (8.7)	17.4-19 (17.9)	4.1-4.2 (4.1)	16.6-17.2 (17)	12-14 (13)	6-9 (8)	18-19 (18)	9-13 (11)	—
Females (n = 3) (mean)	2.7-2.8 (2.8)	4.3 (4.3)	15.2-16.1 (15.7)	3.8-4.1 (4)	7.3-7.9 (7.6)	16.4-17.9 (17.4)	4.2-4.5 (4.3)	15.6-16.9 (16.3)	12-14 (13)	8-9 (9)	16-17 (17)	8-10 (9)	19-21.5 (20.3)
<i>C. rufidulus</i> Saussure, 1878 Female Lectotype	2.9	4.5	20	4.5	6.4	?	?	?	?	?	?	?	21
Males (n = 3) (mean)	2.9-3.2 (3)	4.6 (4.6)	19.9-20.9 (20.1)	4-5.1 (4.6)	6.9-7.3 (7.1)	18.7-20.1 (19.3)	4.3-4.7 (4.5)	17.2-18.5 (17.6)	8-10 (9)	5-7 (6)	14-16 (15)	7 (7)	—
Females (n = 3) (mean)	2.5-3.4 (3.3)	4.5-5.2 (5)	20-23.8 (22.5)	4.5-5.4 (5.1)	6.4-8 (7.6)	19.8-20.3 (20.1)	4.9 (4.9)	18.2-18.8 (18.5)	10-11 (10)	8 (8)	15-18 (17)	8-9 (9)	19.2-22.8 (21)

Cardiodactylus guttulus (Matsumura, 1913)

Grylloides guttulus Matsumura, 1913: 36.

Gryllopsis guttula – Chopard 1967: 33. — Otte 1994: 11. — Eades *et al.* 2008 (Orthoptera Species File Online).

Cardiodactylus novaeguineae – Shiraki 1930: 233. — Oshiro *et al.* 1981: 25; 1995: 43. — Warati *et al.* 2008: 12.

Cardiodactylus guttulus – Ichikawa 1999: 105. — Ito & Ichikawa 2003: 60. — Ichikawa *et al.* 2006: 468. — Warati *et al.* 2008: 15. — Robillard & Ichikawa 2009: 887 (redescription). — Nattier *et al.* 2011: 2201 (molecular phylogeny). — Eades *et al.* 2013 (Orthoptera Species File Online).

Cardiodactylus boharti Otte, 2007a: 349; 2007b: 30. — Robillard & Ichikawa 2009: 887 (synonym name of *C. guttulus*). — Eades *et al.* 2013 (Orthoptera Species File Online).

TYPE MATERIAL. — **Holotype female**: Japan: Okinawa: Riukiu [Ryūkyū] (K. Kuroiwa) (Hokaido University). Not examined.

TYPE LOCALITY. — Okinawa, Ryukyu islands.

REDESCRIPTION AND DISTRIBUTION. — See Robillard & Ichikawa (2009).

Cardiodactylus haani Saussure, 1878
(Figs 2C, 3A, 5)

Cardiodactylus haani Saussure, 1878: 523. — Kirby 1906: 88. — Chopard 1937: 118; 1968: 351. — Otte 1994: 65; 2007: 345 (specimens of another species misidentified as *C. haani*). — Robillard & Desutter-Grandcolas 2004a: 291. — Eades *et al.* 2013 (Orthoptera Species File Online). — this study > valid species, novaeguineae species group.

TYPE MATERIAL. — **Female lectotype** (new designation): [Indonesia] Gebeh [Gebe Island], [H. A.] Bernstein (Leiden).

Paralectotype (new designation): same information as lectotype, 1 ♀ (RMNH).

OTHER MATERIAL EXAMINED. — [Indonesia], no precise localities, Sumatra exp, 1877-1878, #182, 1 ♀ (RMNH). [Indonesia] Ile Gebeh [Gebe Island], coll. Meyer Dür, 1 ♀ (MNHN-EO-ENSIF3148).

TYPE LOCALITY. — Indonesia, Gebe Island (Maluku Islands, West of New Guinea).

REMARKS

Large female specimens from the type locality mentioned in Saussure (1878) and corresponding to the original description of *C. haani* were localized in Leiden despite absence of type label and clear identification (one was in a box labeled *C. novaeguineae* and the other in a box labeled *Nisitrus vittatus* (Haan, 1842)). The only information on the labels of these two specimens is “Bernstein, Gebeh”, one specimen having a hand written label and the other one a printed, more recent label. According to Miracle *et al.* (2007), Dr. H. A. Bernstein was a collector of renown from the Netherlands, who collected ethnological and zoological material in Halmahera and the surrounding islands, from 1860 to his death in 1865, for the National Museum of Ethnology and the Museum of Natural History of Leiden. These dates and places being conform with the date of description of *C. haani* in 1878 and type locality (Gebe is a small island near Halmahera Island), I am confident that the two females constitute the type material examined by Saussure. I therefore designate one as the lectotype and the other one as a paralectotype of *C. haani*. No male material is available from Gebe Island, so the male of the species remains unknown.

These large type specimens and the additional specimens from Gebe Island (two other females) greatly differ from the specimens studied by Otte (2007a) for his brief redescription of *C. haani*. These specimens are from the main island of New Guinea, while Gebe is a smaller, separate island, west of New Guinea, part of the Makulu Islands. The species mentioned by Otte (2007a) as *C. haani* is clearly another species close to *C. novaeguineae* and needing a formal reanalysis.

REDESCRIPTION

Size large, probably one of the largest species of the genus. Colouration contrasted and characteristic, dark orange brown and yellow. Vertex orange brown with faint longitudinal bands; area posterior to eyes with a narrow yellow band. Fastigium elongate, dark brown, its lateral edges yellow. Face mostly yellow, with two dark brown vertical stripes between antennae; mouthparts yellow brown, with a variable dark brown patch on clypeus; maxillary palpi brown.

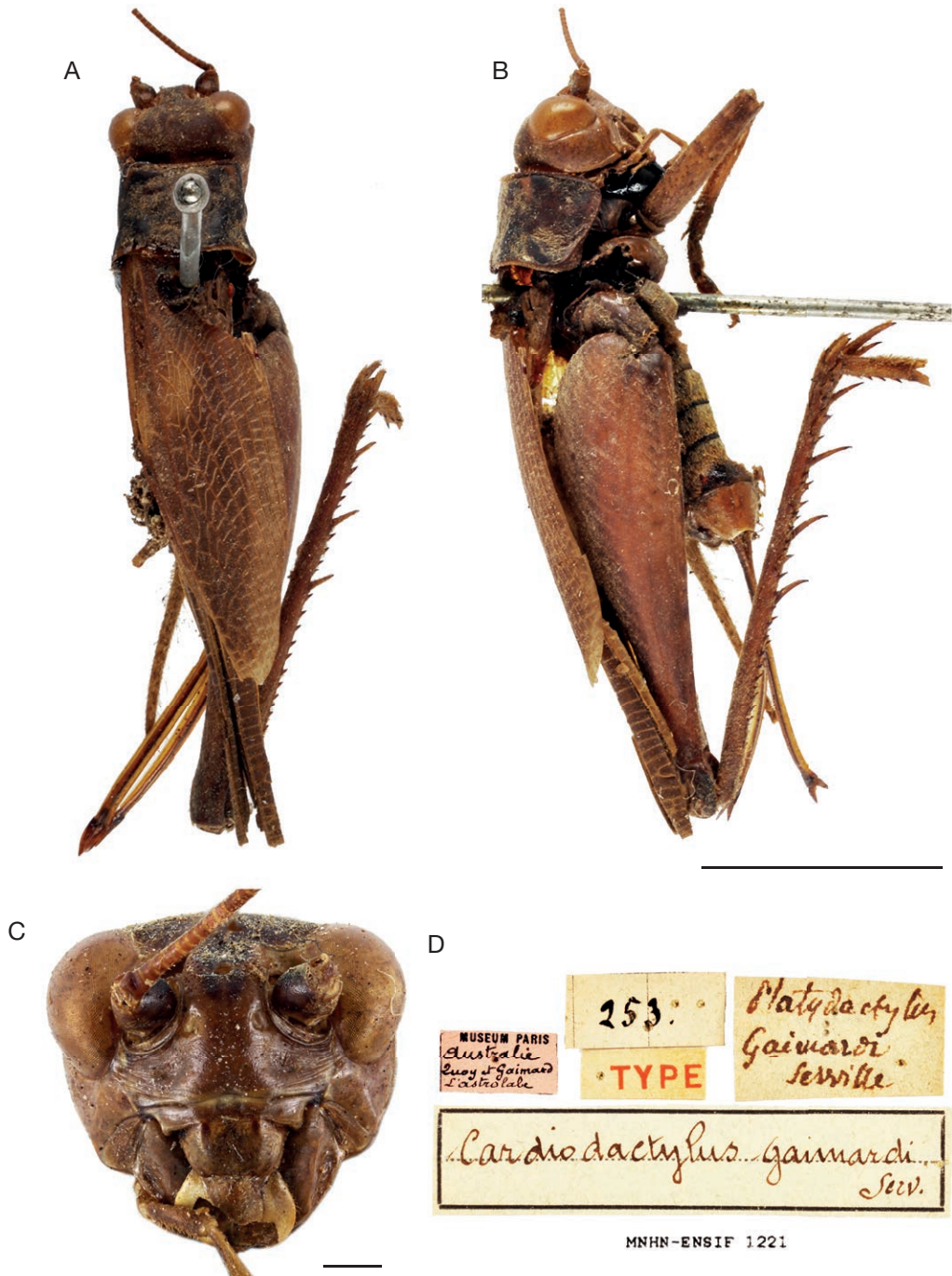


FIG. 4. — *Cardiodactylus gaimardi* (Serville, 1838), female lectotype: **A**, dorsal view; **B**, lateral view; **C**, head in facial view; **D**, labels. Scale bars: A, B, 1 cm; C, 1 mm.

Scapes yellow brown mottled with orange brown. Antennae orange brown, their base dark brown. Lateral part of head orange brown with a yellow area below eyes. Pronotum posterior margin curved but not bisinuated; dorsal disk mostly dark brown, anterior half with two yellow spots on anterior angles and two yellowish transverse symmetrical stripes, posterior half black; lateral lobes homogeneously almost homogeneously dark brown, dorsal area almost black. Legs almost homogeneously dark orange brown, knees of FIII slightly darker. HW tail dark brown with yellow veins. Abdomen yellow brown mottled with dark brown; subgenital plate brown with a dark brown median area. Cerci long, yellowish with dark brown spots.

Female

FW colouration very contrasted, cells mostly dark brown with yellow veins, including longitudinal and transverse veins; anterior region of FWs with a yellow sclerotisation; lateral region with a white patch near FW mid-length; posterior part of CuA/M and complete R/Sc area orange brown to dark brown, including cells and veins. Dorsal field with 11-13 ($m = 12$; $n = 4$; lectotype = 12) strong longitudinal veins. Lateral field mostly dark brown, except Sc, 7-8 ($m = 7$, $n = 4$) projections of Sc and 4-5 ($m = 5$, $n = 4$) more ventral veins ($m = 5$, $n = 4$) yellow, the membrane between them dark brown. Ovipositor shorter than FIII, apex very slightly denticulate on dorsal edge (Fig. 2C).

Female genitalia (Fig. 3A). Copulatory papilla rounded, with two basolateral sclerites; apex rounded, slightly sclerotised, curved dorsally.

Male. Unknown.

Measurements

See Table 2.

Cardiodactylus philippinensis Bolívar, 1913

Cardiodactylus haani philippinensis Bolívar, 1913: 260. — Chopard 1968: 352.

Cardiodactylus philippinensis – Otte 1994: 66 (valid species); 2007: 343. — Robillard & Desutter-Grandcolas

2004a: 291. — Eades *et al.* 2013 (Orthoptera Species File Online). This study > *nomen dubium*.

TYPE MATERIAL. — **Male type:** Philippines. Mindanao I., no precise localities (MNCN, lost).

TYPE LOCALITY. — The locality mentioned by Bolívar is Mindanao without precision.

REMARKS

The type specimen of *C. philippinensis* could not be found in MNCN, Madrid where it is supposed to be deposited (Paris 1993; M. Paris pers. comm. 2012). It is consequently considered as lost. According to the original description, the species is known from the Philippines and was briefly described based on a single male specimen from the large island of Mindanao, without precise locality. Despite Otte (2007a) mentions that *C. philippinensis* is the only species of *Cardiodactylus* from Mindanao, several species are described from this island that is famous for its biodiversity (some are described by Otte [2007a] himself). For these multiple reasons, it is impossible to compare *C. philippinensis* to other species of *Cardiodactylus*, to redescribe it and/or to define a neotype series. Consequently, this species should be considered as *nomen dubium*.

Cardiodactylus pictus Saussure, 1878 (Figs 2D, 3C, 6, 7)

Cardiodactylus pictus Saussure, 1878: 521. — Kirby 1906: 88. — Chopard 1915: 166; 1931a: 17; 1937: 118; 1968: 351. — Wilemse 1926: 521. — Robillard & Desutter-Grandcolas 2004a: 291. — Otte 2007a: 343. — Eades *et al.* 2013 (Orthoptera Species File Online). — this study > valid species, *effordi* species group.

Cardiodactylus novaeguineae – Otte 1994: 66 (synonymy).

TYPE MATERIAL. — **Male lectotype** (new designation): [Indonesia]: Molukum [Maluku Islands], #3808, col. Br. V. W. [Brunner von Wattenwyl] (NHMW) (examined). **Paralectotypes:** [Indonesia]: Key Ins. [Kai Islands], coll. Br. v. [Brunner von Wattenwyl], 1 ♂, 22-VI-[18]41 (MNHN-EO-ENSIF3149); 1 ♀, (MNHN-EO-ENSIF3150) (new designations).

OTHER MATERIAL EXAMINED. — [Indonesia]: Key Ins. [Kai Islands], 2 ♂♂, 2 ♀♀ (MNHN). Kei Eil [Kai

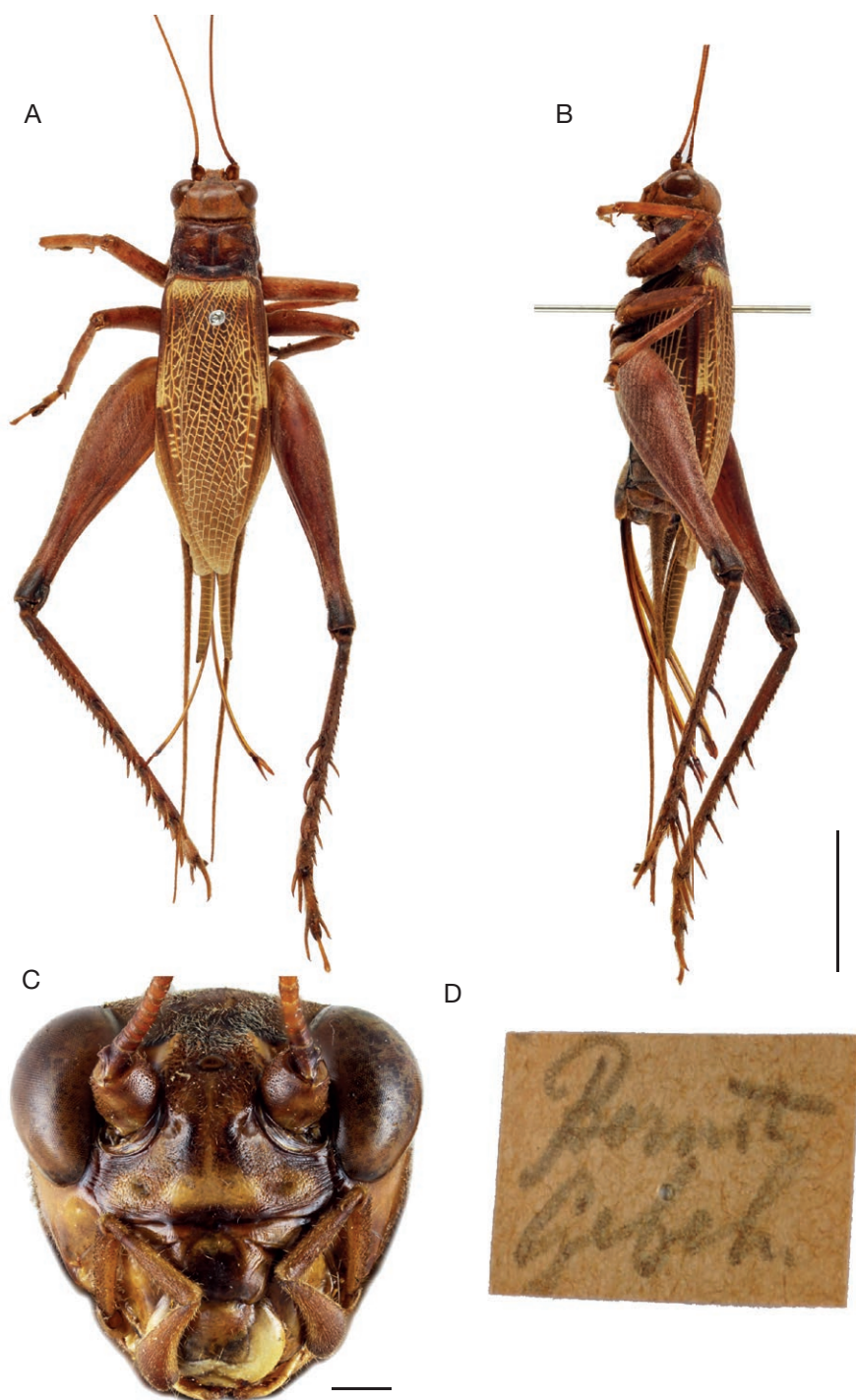


FIG. 5. — *Cardiodactylus haani* Saussure, 1878, female lectotype: **A**, dorsal view; **B**, lateral view; **C**, head in facial view; **D**, labels. Scale bars: A, B, 1 cm; C, 1 mm.

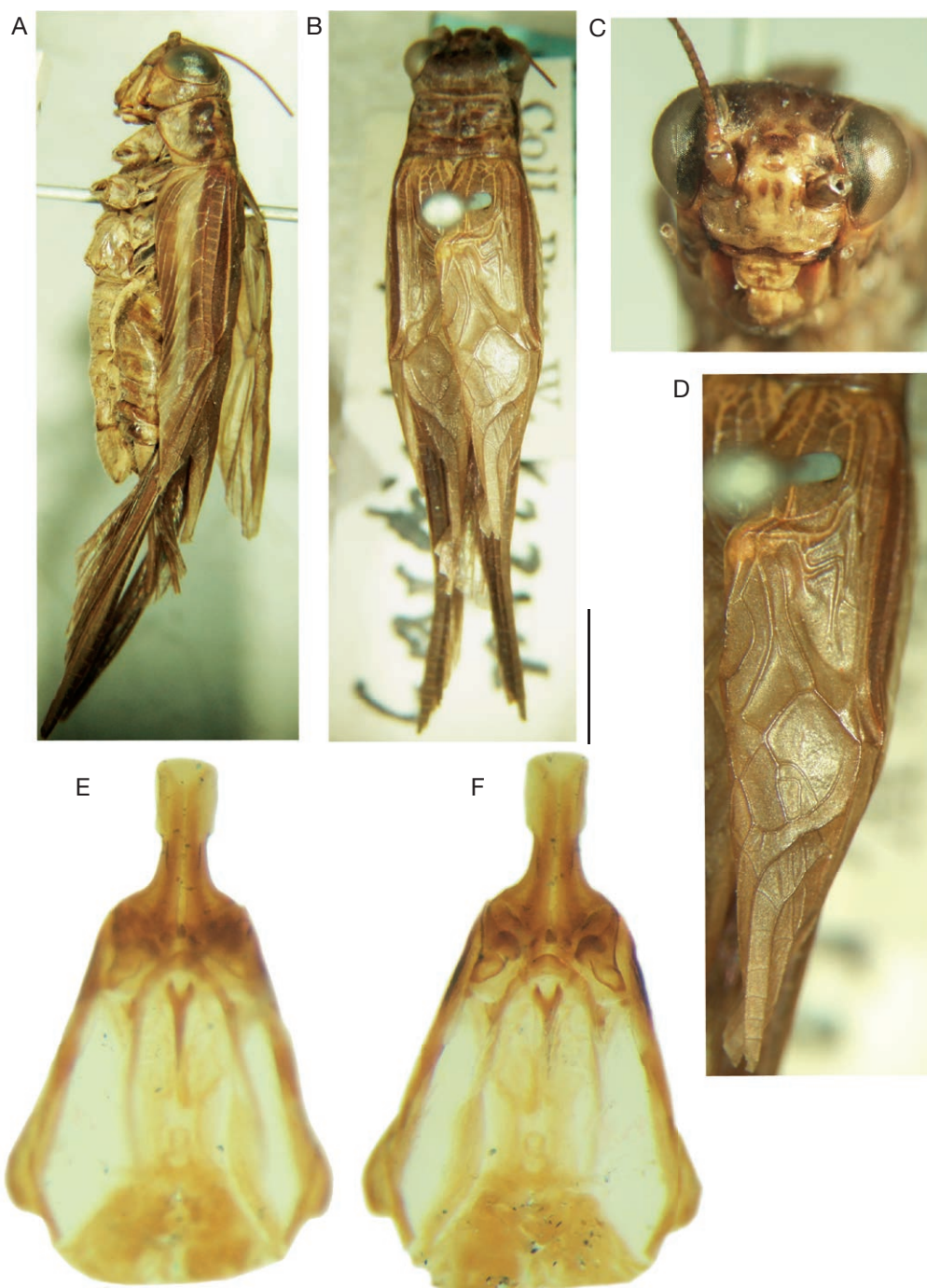


FIG. 6. — *Cardiodactylus pictus* Saussure, 1878, male lectotype: **A**, lateral view; **B**, dorsal view; **C**, head in facial view; **D**, FW venation; **E**, male genitalia in dorsal view; **F**, male genitalia in ventral view. Scale bar: A, B, 5 mm.

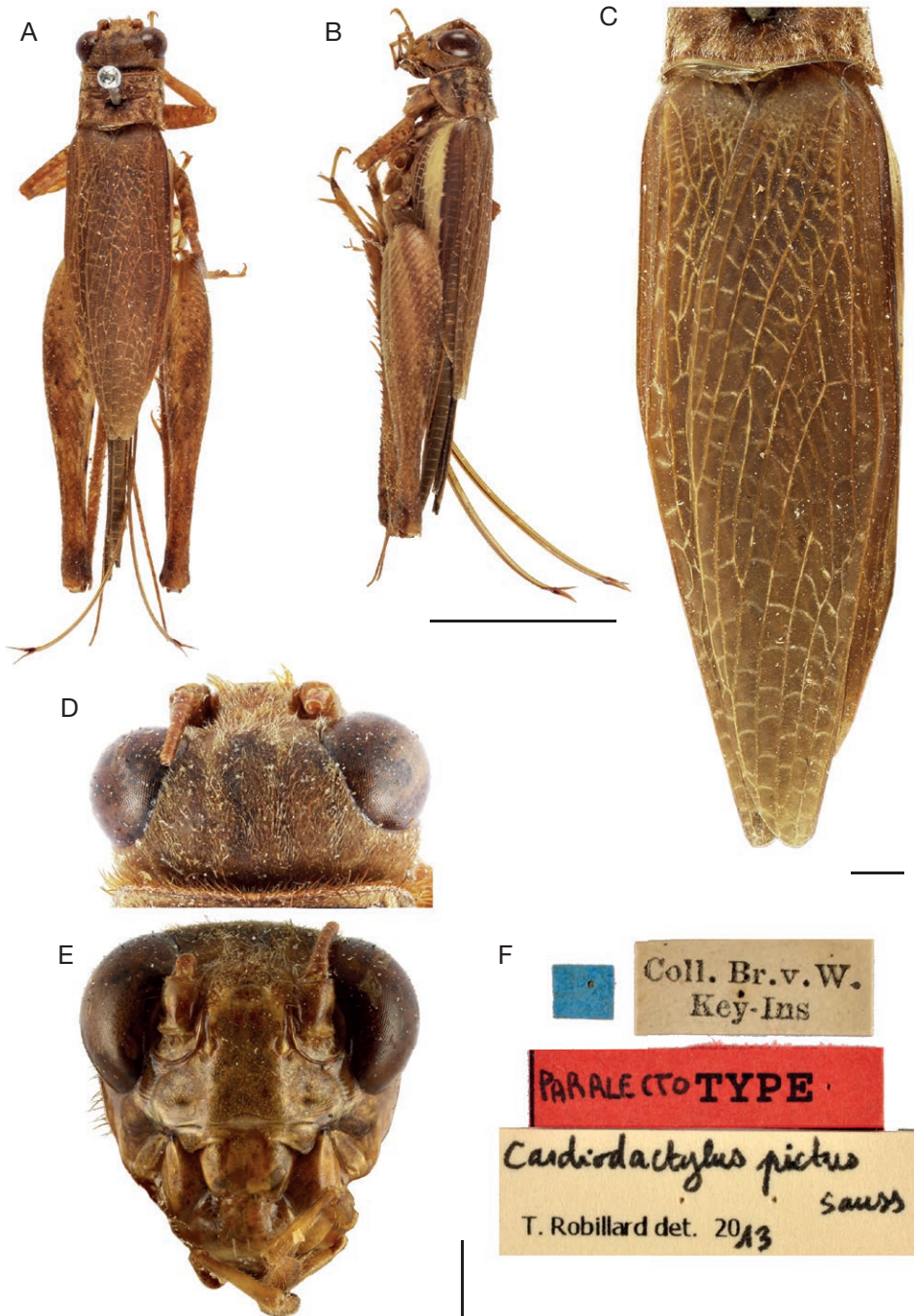


FIG. 7. — *Cardiodactylus pictus* Saussure, 1878, female paralectotype: **A**, dorsal view; **B**, lateral view; **C**, FW venation; **D**, head in dorsal view; **E**, head in facial view; **F**, labels. Scale bars: A, B, 1 cm; C-E, 1 mm.

Islands], H. C. Siebers, 1922: Elat, 1 ♂, #156, 1 ♀, #159; Gn [Gunung = Mount] Daab, #79 (MNHN). Key Tual [Kai Islands], 1 ♂, #22.674., Rohde, ex coll. H. Fruhstorfer (MNHN).

TYPE LOCALITY. — Indonesia, Maluku Islands, no precise localities.

REMARKS

The species is valid and has not been described under another name since original description. It clearly belongs to the *effordi* species group according to its small size, colouration, shape of pronotum and male genitalia.

REDESCRIPTION

Size small for the genus, colouration mostly brown with a wide pale band on lateral field of FW in both male and female. Eyes large and prominent, vertex dark brown, fastigium trapezoidal, yellowish with a median brown patch. Face and mouthparts almost homogeneously yellow brown, with two faint dark spots between antennae. Scapes yellow brown, with a dark brown ring. Lateral part of head yellow brown. Pronotum posterior margin slightly bisinuated; dorsal disk of pronotum brown, anterior margin yellow brown with black spots; lateral lobes dark brown posteriorly, ventral margin yellow brown with a dark brown anterior pattern. Fore and median legs orange brown, with faint dark spots on femora and faint dark rings on tibiae; legs III almost homogeneously orange brown, sometimes mottled with dark brown; knees dark brown. HW tail dark brown and long, three times longer than pronotum.

Male (Fig. 6)

FWs mostly dark brown, with yellow veins basally. 1A bisinuated, with 135 stridulatory teeth on the transverse region of 1A and *c.* 20 teeth on the angle (total = 155 teeth, *n* = 1). Harp longer than wide, with one strong W-shaped harp vein and a faint anterior one. Mirror (d1) large, with an accessory vein separating a large anterior cell and a small posterior one. Cell d2 as wide as mirror, well defined. Apical field long and pointed, with 4-5 (*m* = 5, *n* = 4) cell alignments. Lateral field

with 6-8 (*m* = 7, *n* = 4) projections of Sc and 4-5 (*m* = 5, *n* = 4) more ventral veins.

Male genitalia (Fig. 6E, F). Posterior part of pseudepiphallus forming a characteristic flat rectangular plate; anterior part trapezoidal, median area concave, its anterior margin slightly indented and covered with short setae. Rami long and strong, their apical stems long and slightly convergent. Ectophallic arc complete, curved posteriorly; ectophallic apodemes very long and thin, their basis with a sclerotised anterior expansion. Endophallic sclerite elongated, adodeme including a dorsal crest and narrow lateral lamellas.

Female (Fig. 7)

FWs dark brown, veins yellow brown, with 9 (*n* = 3) strong longitudinal veins. Lateral field with 6-7 projections of Sc and 4 more ventral veins (*n* = 3). HW forming a long tail posteriorly. Ovipositor very long, apex slightly denticulate dorsally (Fig. 2D).

Female genitalia (Fig. 3C). Copulatory papilla conical laterally, with a thin basal sclerotisation.

Measurements

See Table 2.

Cardiodactylus praecipuus (Walker, 1869) (Fig. 8)

Platydictylus praecipuus Walker, 1869: 83.

Madasumma praecipua – Kirby 1906: 94. — Chopard 1925: 533; 1929: 49; 1936: 75; 1968: 351; 1969: 312. — Shiraki 1930: 233.

Cardiodactylus praecipuus – Chopard 1936: 75; 1968: 351; 1969: 312. — Bhowmik 1979 [1981]: 44. — Otte 1994: 66; 2007: 343 (probably not belonging to *Cardiodactylus*). — Robillard & Desutter-Grandcolas 2004a: 291. — Eades *et al.* 2013 (Orthoptera Species File Online). — this study > *nomen dubium* (confirmation)

Orbega pallida Walker, 1869: 91. — Chopard 1933: 171 (nymph of *Cardiodactylus*).

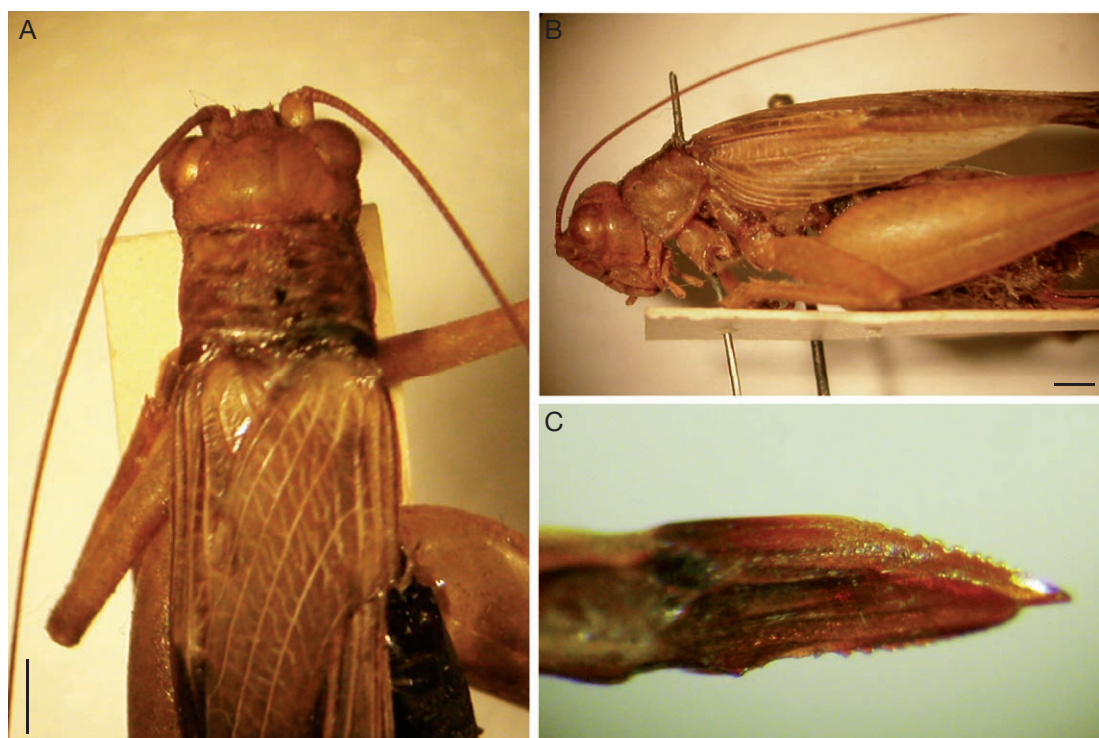


FIG. 8. — *Cardiodactylus praecipuus* (Walker, 1869), female lectotype: **A**, dorsal view; **B**, lateral view; **C**, apex of ovipositor. Scale bars: A, B, 1 mm.

TYPE MATERIAL. — **Female lectotype:** [Sri Lanka] Ceylon, #212, det by B. Uvarov, (BMNH) Examined.

TYPE LOCALITY. — Sri Lanka (no precise localities).

REMARKS

Otte (2007) hypothesised that this species described based on a single female was probably wrongly placed under *Cardiodactylus* by Chopard (1968). Re-examination of the type in London however confirms that this is a specimen of *Cardiodactylus* belonging to the large species group novaeguineae (Fig. 8). But as Otte (2007a) remarked, the occurrence of this only specimen of *Cardiodactylus* in Sri Lanka is awkward, as this island is far outside of the range of distribution of the genus. Instead of a wrong identification, this may result from a label error of the specimen studied by Walker (1869). I consider this species as a *nomen dubium*.

Cardiodactylus rufidulus Saussure, 1878 (Figs 2E, 3D, 9, 10, 11)

Cardiodactylus rufidulus Saussure, 1878: 523. — Kirby 1906: 88. — Chopard 1937: 118 (type not found); 1951: 481; 1968: 352. — Otte & Alexander 1983: 309 (*nomen dubium*, type not found in Paris or Geneva). — Otte 1994: 66 (*nomen dubium*); 2007a: 343 (*nomen dubium*). — Eades *et al.* 2013 (Orthoptera Species File Online: *nomen dubium*). — this study > valid species, *effordi* species group.

Cardiodactylus sp. near *rufidulus* – Robillard & Desutter-Grandcolas 2004a: 273; 2004b: 479 (morphological phylogeny); 2006: 644 (molecular and morphological phylogeny). — Robillard 2004: 29; 2006: 675 (morphological phylogeny).

Cardiodactylus tathimani Otte, 2007a: 354. — Otte 2007b: 32. — Eades *et al.* 2013 (Orthoptera Species File Online). This study: junior synonym of *C. rufidulus*, new synonymy (see remarks).

TYPE MATERIAL. — **Female lectotype** (new designation): [Solomon Islands]: Arch. Salomon, I. San George [San Jorge Island], #803.41, #152, 1841, Jacquinet (MNHN-EO-ENSIF3151).

OTHER MATERIAL EXAMINED. — [Solomon Islands] Solomon Is. Guadalcanal, Nalimbiu R. [river], 12.IX.1963, #0122, M. McQuillan, 1 ♂, identified *C. rufidulus* by L. Chopard; Solomon Is, Malaita, Auki, 2-20m, 22.IX.1957, J. L. Gressitt, 1 ♀; Solomon Islands, Guadalcanal, Mt Austen, forest clearing, 24. VIII.1965, 1 ♀, Roy. Soc. Exped (BMNH, B. M. 1966-1); Solomon IS, Guadalcanal, Suta, 500-1200 m, 27.VI.1956, 1 ♂, J. L. Gressitt; Solomon IS., Malaita, Tangtalau, 200 m, 30.IX.1957, 1 ♀, J. L. Gressitt; Solomon IS., Malaita, Tangtalau, 150-200 m, 25.IX.1957, 1 ♀, J. L. Gressitt; Solomon IS. Guadalcanal, Rua Vatu, 20.XI.1954, #1565, E. S. Brown: 1 ♂, determined *C. rufidulus* by B. C. Townsend (BMNH), 1 ♀, 1 ♂ (BMNH); Solomon IS. Guadalcanal, Rua Vatu, 07.IV.1955, 1 ♂, E. S. Brown (BMNH-BM.1955-33); Solomon IS., Malaita, Dala, 55 m, 12.VI.1964, ex coll. BISHOP, 1 ♂, J. & M. Sedlacek; Kiwi Creek, Guadalcanal, 21.VII.1944, 1 ♀, G. E. Milliron; Solomon IS., Guadalcanal, Honiara, 0-100 m, XII.1976, 1 ♂, N. H. L. Krauss (BMNH-BM.1984-365); Solomon IS., Malaita, Makwanu, 25.IX.1963, #7824, 1 ♀, M. McQuillan; Solomon IS. Malaita, Auki, 2-20 m, 22.IX.1957, 1 ♀, J. L. Gressitt; Solomon IS. Guadalcanal, Kerl***?, 20.IX.1954, #1049A, 1 ♀, E. S. Brown (BMNH). [Solomon Islands], Buma (Malaita) Salomonen, V.1929, 1 ♂; E. Paravicini, identified *C. rufidulus* by L. Chopard.

TYPE LOCALITY. — Locality mentioned by Saussure (1878) is “La Nouvelle Hollande”. The labels mention “Arch. Salomon, I. San George”, which probably refers to San Jorge Island in the Solomon archipelago, south of Isabel Island.

REMARKS

The species *C. rufidulus* has been repeatedly treated as a *nomen dubium*, since the type specimen, a single female supposed to be deposited in Paris, from “La Nouvelle Hollande” (which refers to Solomon Islands in the case of *C. canotus*, see above), was considered lost by Otte & Alexander (1983) and Otte (1994, 2007a). I confirm that the female type to *C. rufidulus* is not in Paris, despite a series of more recent specimens matching the original description have been identified *C. rufidulus* by L. Chopard. A series of specimens from the same species was found in London, among which one female is labelled “Museum Paris” and matches the

original description, locality and measurements of the type. This female also lacks hind legs, and the dates of collection and of depository in Paris Museum (1841) are consistent with the hypothesis that this specimen could be the missing type of Saussure. I consequently consider that this female specimen is the lost type from Paris, which is designated here as the lectotype of the species. However no explanation can be given to explain why it was found in London. Old types rarely bear a “type” label, so this legless female specimen could have been exchanged with London by someone who did not recognise it as the type of the species. One female specimen from MHNG also lacking hind legs and identified *C. rufidulus* (examined) was also supposed by Hollier *et al.* (2013) to be the type of Saussure, but this female is from New Guinea (locality on label is “Katow”) without collection date, and does not match the particular coloration pattern of the species.

In the meantime, specimens of the same species have been described by Otte (2007a) as *C. tathimani*, as clearly shown by the photographs of habitus and male genitalia. *C. tathimani* should consequently be considered as a junior synonym of *C. rufidulus* (new synonymy).

REDESCRIPTION

Size average for the genus, with a slender shape; colouration mostly yellow or pale orange brown with dark brown and whitish patterns on dorsum. Shape of head differing from other species of the genus: eyes large and prominent, vertex and fastigium on different levels, fastigium longer than wide, quite narrow, with a median furrow. Vertex anterior region black, posterior region orange brown to yellow, with four faint brown longitudinal lines. Fastigium yellow brown. Face, mouthparts and maxillary palpi almost homogeneously yellow or orange brown, with two faint dark spots between antennae. Scapes rather large, yellow brown. Lateral part of head yellow brown. Pronotum posterior margin slightly bisinuated; dorsal disk posterior half dark brown to black, anterior area almost homogeneously yellow or orange brown, sometimes with a few black spots, lateral edges yellow; lateral lobes homogeneously yellow or orange brown, the dorso-lateral angle



FIG. 9. — *Cardiodactylus rufidulus* Saussure, 1878, female lectotype: **A**, dorsal view; **B**, lateral view; **C**, head in facial view; **D**, labels. Scale bars: A, B, 1 cm; C, 1 mm.

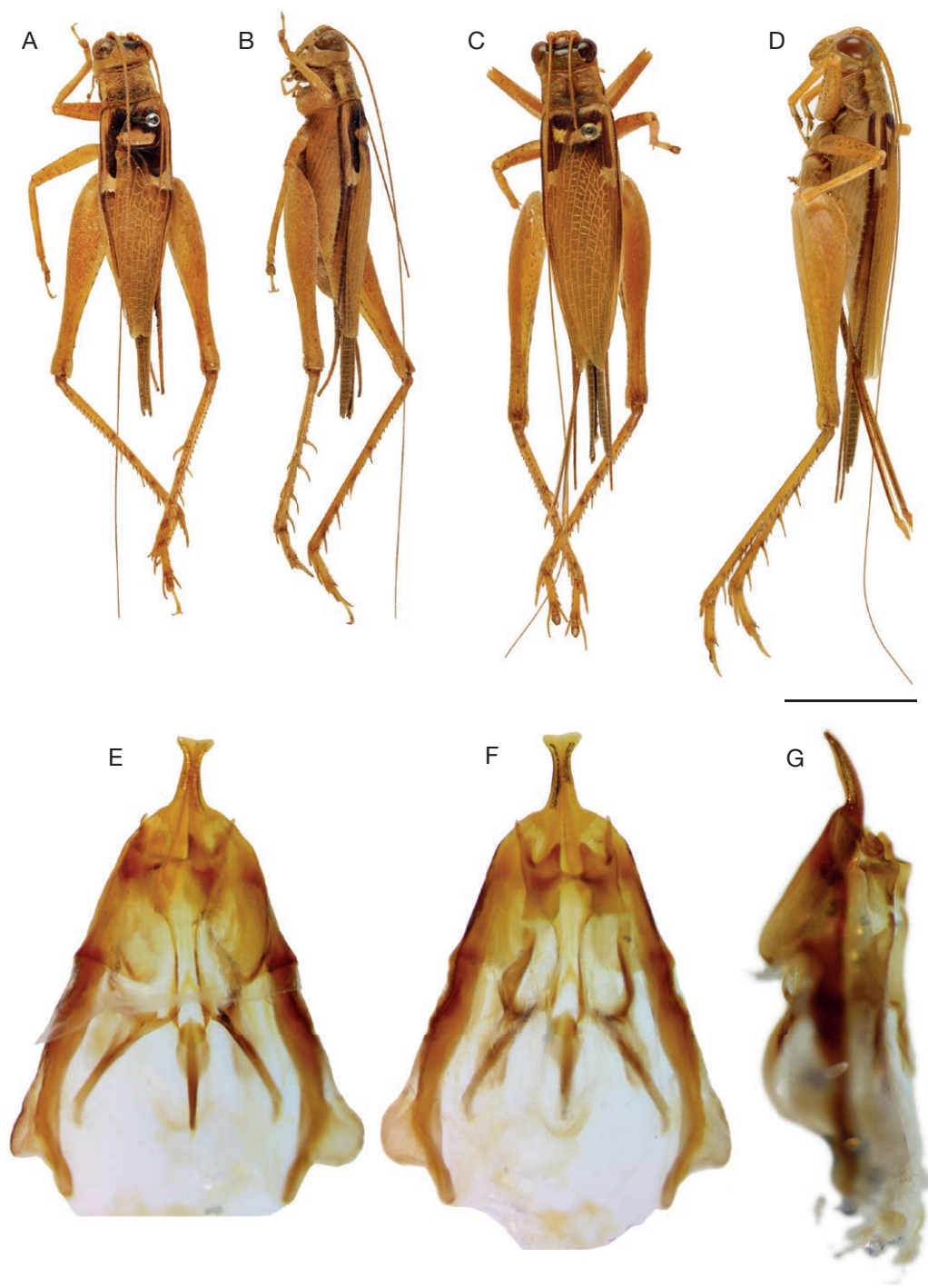


FIG. 10. — *Cardiodactylus rufidulus* Saussure, 1878: **A**, male in dorsal view; **B**, male in lateral view; **C**, female in dorsal view; **D**, female in lateral view; **E**, male genitalia in dorsal view; **F**, male genitalia in ventral view; **G**, male genitalia in lateral view. Scale bars: A-D, 1 cm; E-G, 1 mm.

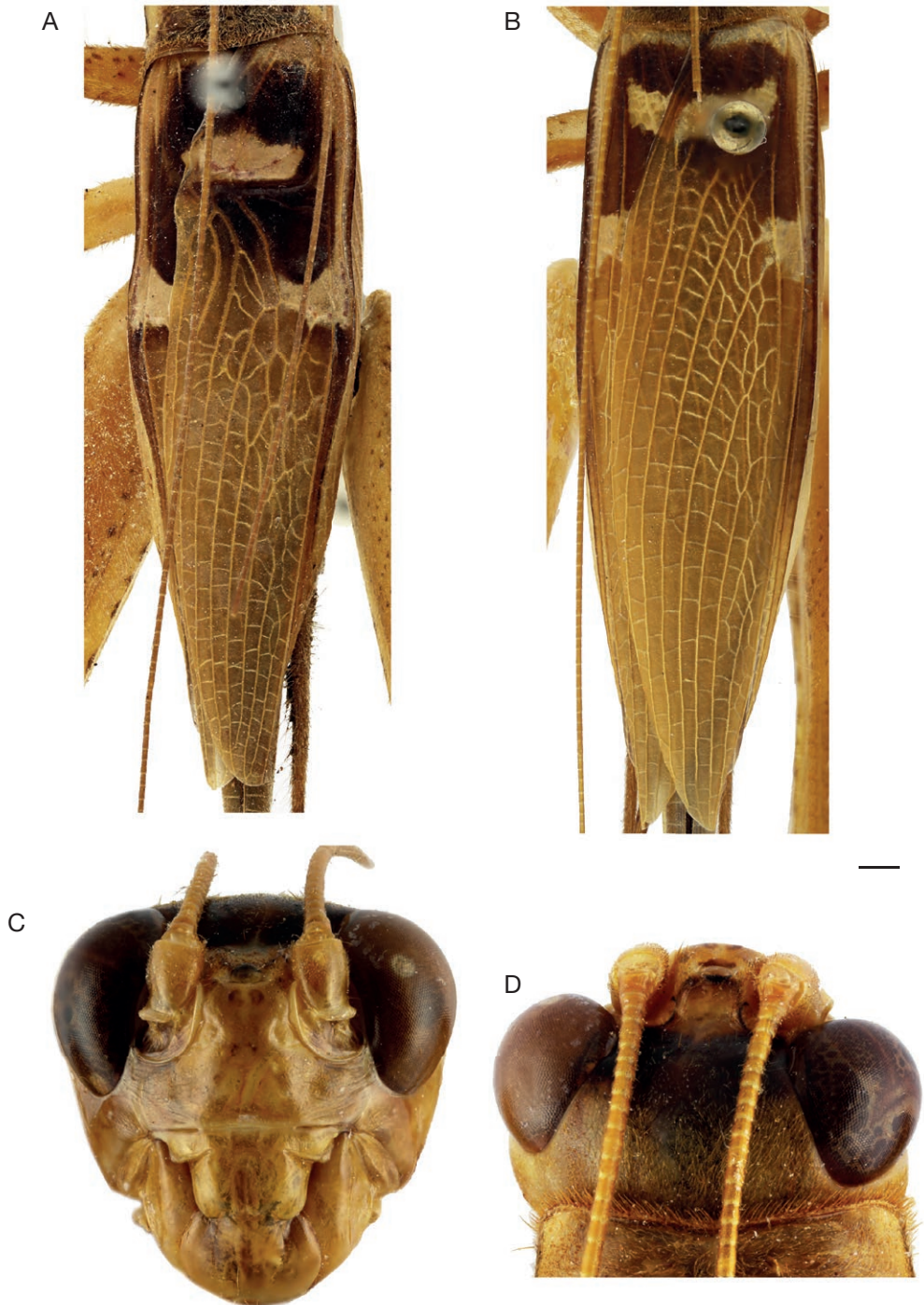


FIG. 11. — *Cardiodactylus rufidulus* Saussure, 1878: **A**, male FW venation; **B**, female FW venation; **C**, head in view facial; **D**, head in dorsal view. Scale bars: 1 mm.

underlined by a black line sometimes interrupted. Legs homogeneously orange brown. TaIII-1 with a row of 2–4 spines ($m = 3$, $n = 6$) on external side in addition to dorsal rows. HW tail grey brown, twice longer than pronotum. FW colouration very characteristic and similar in both sexes despite presence of male stridulatory apparatus: FW mostly orange brown, anteriorly dark brown with two wide whitish or yellow areas, a basal one including base of FW and of anal veins, and one near FW quarter (anterior to file in male); external margin of FW whitish basally, including bases of CuA and M, with a whitish spot near third of FW length (posterior corner of harp in male). Lateral field orange brown except R, R/Sc area and posterior part of M/R area dark brown. HW tail twice longer than pronotum, grey brown. Abdomen yellow brown to grey brown. Cerci very long for the genus, yellowish, their inner basal region dark brown.

Male

FWs narrow for the genus, mostly orange brown or yellow brown, anterior region of dorsal field dark brown, including the harp and the region anterior to the file. 1A slightly bisinuated, with 250 stridulatory teeth on the transverse region of 1A, $c.$ 30 on the angle and $c.$ 40 on the basal longitudinal part of the file (total = 320 teeth, $n = 1$). Harp small, longer than wide, with a weak W-shaped harp vein and a fainter anterior one; whitish posterior angle of harp forming a semi-circular sclerotisation. Mirror (d1) not differentiated from the rest of D alignment. Apical field long and pointed, with 4–5 ($m = 4$, $n = 4$) cell alignments. Lateral field with 9–12 ($m = 10$, $n = 4$) projections of Sc and 4–5 ($m = 4$, $n = 4$) more ventral veins.

Male genitalia (Fig. 10E–G). Posterior part of pseudepiphallus narrow, ended by a triangular plate; anterior part trapezoidal, median area concave, its anterior margin slightly indented. Rami long, as long as pseudepiphallic sclerite, their apical stems long and slightly convergent. Pseudepiphallic parameres large, trilobate, the long posterior lobe pointed with a preapical hook, the two other lobes pointed and convergent. Ectophallic arc complete but thin, v-shaped; ectophallic apodemes thin, divergent,

their basis with a ventral sclerotised expansion forming a rectangular plate; ectophallic fold widened apically, with thin lateral sclerites, median area possibly glandular. Endophallic sclerite small, with a triangular posterior expansion and small lateral arms; apodeme forming a thick anterior expansion, including a dorsal crest and lateral lamellas fused together.

Female

FW colouration with similar pattern as in male, with 8–11 ($m = 10$; $n = 4$; lectotype = 11) strong parallel longitudinal veins on dorsal field. Lateral field with 9 projections of Sc and 4–5 more ventral veins ($n = 4$). Ovipositor (Fig. 2E) as long as FIII, apex elongate, smooth on both dorsal and ventral edges.

Female genitalia (Fig. 3D). Copulatory papilla conical, with a thin basal sclerotisation; apex elongate.

Measurements

See Table 2.

Acknowledgements

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